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Carbon sequestration

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Carbon is essential for life on earth -- it sustains biological activity, diversity, and ecosystem productivity. Humans and animals release carbon dioxide (CO_2), while plants take it in and release oxygen, returning carbon to the soil when they die. It's generally accepted that the carbon cycle flowed more or less in balance until the late 1880s.

It has been documented that the world's CO_2 levels have increased over the last century. And, although doubt remains regarding the cause or causes -- whether from human activity or a natural cyclical change in the environment -- there is general agreement that at least some rise in CO_2 levels result from human activity. Regardless of the cause, we do know that emissions to the atmosphere from power and industrial plants and vehicles have increased CO_2 in the atmosphere to levels above the pre-industrial trend.

What is carbon sequestration?

Carbon sequestration is the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. The idea is (1) to prevent carbon emissions produced by human activities from reaching the atmosphere by capturing and diverting them to secure storage, or, (2) to remove carbon from the atmosphere by various means and 'storing' it in the soil.

How does carbon sequestration work?

Reducing atmospheric CO_2, that is sequestering carbon, can take place three ways:

- carbon production or trapping carbon within plants. The more permanent vegetation that is present, the more CO_2 is required.
- minimizing organic carbon mineralization. That means managing crops and soil to reduce conditions that break down or oxidize organic matter -- letting plant material decompose more slowly and naturally.
- reducing soil erosion and keeping carbon trapped in the soil. Eroded soil is exposed soil -- and exposed carbon.

Managing for carbon sequestration

When it comes to managing soil for organic matter and carbon sequestration, there is no single practice that works alone to enhance soil function, and no prescribed set of practices can work everywhere. The goal is improved soil organic matter and soil function everywhere -- croplands, pastures, and woodlands.

The most often recommended practices include some familiar strategies and some not so familiar. Using higher residue cover crops and rotations, such as oats and hay, creates larger volumes of plant biomass and stores more carbon in the soil. And less soil disturbance means less erosion. Some of the best candidates include a high-biomass crop rotation and cover crops, residue management (mulch-till, no-till, strip-till), compaction prevention, and rotational grazing.

Conservation tillage gives this central Iowa field the protection it needs from wind and water erosion (photo by Lynn Betts, USDA, Natural Resources Conservation Service).

Enlarge [1]

Benefits of Soil Carbon Sequestration

Changes in soil properties and environmental quality. As management changes, benefits might appear in several ways. The first is improved soil structure, with surface structure becoming more stable and less prone to crusting and erosion. Water infiltration could improve, meaning less surface runoff. As soil organic matter increases, soil water and nutrient capacity increases significantly. And crops will fare better during drought because infiltration and water holding capacity have improved.

Also, organic matter and the associated soil biological population will increase in vigor and numbers with more diverse crop rotations. Organic matter also may bind pesticides, suppress disease organisms, and improve crop health and vigor as soil biological activity and diversity increase.

Improvements can be expected in air quality as dust, allergens, and pathogens in the air decline; in water quality as sediment and nutrient loads decline in surface water from better soil aggregation; and in agricultural productivity. Wildlife habitat also is improved with higher residue levels.

One possible future -- managing for carbon sequestration. The concept is real, and Iowa producers should expect more dialogue, not less, about the issue. The longer they pay attention to the issue, the more they will know about it, which puts them in the best position possible when it's time to make a decision. For more detailed information about carbon sequestration, call your local Iowa State University Extension office and request PM 1871, Impact of Tillage and Crop Rotation Systems on Soil Carbon Sequestration.

Managing for 'T'-- is it good enough?

For many years, conservationists have advised farmers and land managers to implement management practices to keep soil erosion at or below the level at which productive soil can be replaced, or a value called 'T'. Now, some conservationists are beginning to reassess this strategy for the following reasons:

First, on many landscapes soil is still eroding at rates greater than T. Even though

important soil savings have been achieved through soil erosion control technology, focusing on organic matter might further reduce erosion.

Second, T is not adequate for resource protection -- at T, the U.S. will continue to displace over a billion tons of soil per year. At those levels, air quality, water quality, and wildlife habitat remain at risk.

Third, controlling soil erosion does not equal sustaining soil function. Keeping soil in place is only part of the job. Soil also has to function well -- holding nitrogen, phosphorus, and pesticides in place and keeping them out of surface water. Soil delivers nutrients and water to growing plants as needed. And soil minimizes the effects of excess water and droughts.

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